भारतीय मानक
Indian Standard

IS 14458 (Part 4) : 2018

पहाड़ी क्षेत्र की रिटेनिंग दिवारें — मार्गदर्शी सिद्धांत

भाग 4 बैण्डेड शुष्क पत्थर चिनाई की दीवारों का निर्माण

Retaining Wall for Hill Areas — Guidelines

Part 4 Construction of Banded Dry Stone Masonry Walls

ICS 93.020

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Hill Area Development Engineering Sectional Committee, CED 56

FOREWORD

The Indian Standard (Part 4) was adopted by the Bureau of Indian Standards, after the draft was finalized by Hill Area Development Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

Retaining walls are structures, which support the backfill and maintain the difference in elevation of the two ground surfaces. They are generally located at the toe of cut slopes on valley side of a hill road section or excavated platform. Retaining walls are effectively utilised to tackle the problems of landslide in hill area by providing support to the fill slopes or cut slopes.

In general, 1 m of extra width in filling and requiring retaining wall at the end may cost more than excavating the same width by cutting inside the hill. However, considering maintenance cost, progressive slope instability and environmental degradation resulting from unprotected excavation, the use of retaining walls becomes essential. This standard (Part 4) is therefore formulated to provide necessary guidelines for construction of banded dry stone masonry retainingwalls for stability of hill slopes this standard is being published in different parts. The following parts have already been published:

(Part 1)	:	1998	Selection of type of wall,
(Part 2)	:	1997	Design of retaining/breast walls,
(Part 3)	:	1998	Construction of dry stone walls
(Part 5)	:	2018	Construction of cement stone masonry walls

Other parts being formulated are:

a) Construction of gabion walls,
b) Construction of RCC crib walls,
c) Design of RCC cantilever walls/buttressed walls/L-type walls, and
d) Design and construction of reinforced earth retaining walls.

Presently various types of retaining walls such as dry stone, gabion, banded dry stone masonry, cement stone masonry or other such retaining walls are preferred for heights up to 4 m. The choice of a particular wall is dependent on the nature of ground, available budget and availability of construction materials. However, it is preferable to construct cement mortar masonry wall or RCC walls, when the height of retaining walls exceeds 4 m.

In most cases, the failures of retaining walls are often resulted, if the provisions of drainage are inadequate especially during rains. But, in case of a banded dry stone masonry walls, the drainage is almost unrestricted and may not create problems. Inadequate section of walls and poor quality construction are other reasons for failure of banded dry stone walls. This standard (Part 4), therefore, provides suitable guidelines to the field engineers for construction of banded dry stone retaining walls. Strict supervision is essential for long life of these types of walls.

The composition of Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RETAINING WALL FOR HILL AREAS — GUIDELINES

PART 4 CONSTRUCTION OF BANDED DRY STONE MASONRY WALLS

1 SCOPE

This standard (Part 4) deals with the construction aspects of banded dry stone masonry retaining walls.

2 REFERENCE

The standard given below contains provisions, which through reference in this text, constitute part of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS No.	*Title*
1123 : 1975	Method of identification of natural building stones (*first revision*)

3 GENERAL

3.1 A banded dry stone retaining wall is a gravity wall, which shall be considered safe if, the following expected conditions of loading are satisfied:

a) It shall be safe against overturning,
b) The shear stress at the base shall be less than shearing strength available,
c) The pressure at the toe shall remain less than the safe bearing capacity of thefoundation material, and
d) No tensile stress develops at the heel.

It may be assumed that there is adequate frictional bond between the cement stone bands and the packed dry stones from face to back and from top to base, so that entire section of the retaining wall acts as one integral unit. This can be achieved by selection of suitable stones and proper construction of cement stone bands.

3.2 Retaining walls are not normally intended to support the soil behind it against slope failures. They are mainly meant to support the active or passive earth pressure from the assumed failure wedge above the base of the wall. Separate treatment and specific design approaches are required to stabilize the existing or probable failure planes in addition to the retaining walls.

3.3 The stability of retaining walls mainly depends upon the allowable bearing pressure of the foundation material particularly under the toe. The compressive strength of well compacted natural soil is usually adequate to support 3m to 4m height of retaining walls. The sliding at the base depends on the coefficient of friction between the wall base and the foundation soil. The total earth pressure above any level along the height of the retaining wall reduces parabolically from base upward, whereas the wall thickness reduces linearly. Therefore in most cases, the critical section in the wall is at the base.

3.4 It should be assured that the quality of construction of the wall is maintained and does not suffer due to lack of supervision, non-availability of skilled labour, improper mixing of mortar, lack of post-construction curing and also sometimes paucity of water in the area.

3.5 After excavation at the toe for road or terrace purpose, the construction of the retaining wall should be taken up as early as possible with least time gap in order to prevent even minor de-stressing of cut slope material.

3.6 A series of retaining walls, one above the other on an unstable or marginally stable slope results in accumulation of earth pressure on to the lower walls leading to destabilization of the slope (*see* Fig. 1).

3.7 The causes of wall failure commonly noticed in the hills as a result of poor construction are:

a) Differential settlement of the foundation during rains,
b) Poor bonding between dry stones and masonry bands within the wall,
c) Roots of big trees pushing the wall from behind,
d) Designed section not fully adopted during construction,
e) Poor backfill material and inadequate compaction in the backfill,
f) Not providing specified inverted filters in the backfill, and
g) Lack of toe protection for walls.

4 MATERIAL

Stones, the main material required for the construction of banded dry stone masonry retaining wall, are generally available in large quantity in hills. To select and utilize them for their satisfactory performance, it shall be necessary to know the various properties which can be determined according to relevant Indian Standards. The strength of rocks depends on its mineral constituents, which form the basis of classification and identification of rocks. Identification of stones,may be done in accordance with IS 1123. In general, fresh or fairly fresh igneous rocks like granite, syenite, charnockite, basalt, etc, form good host rock for

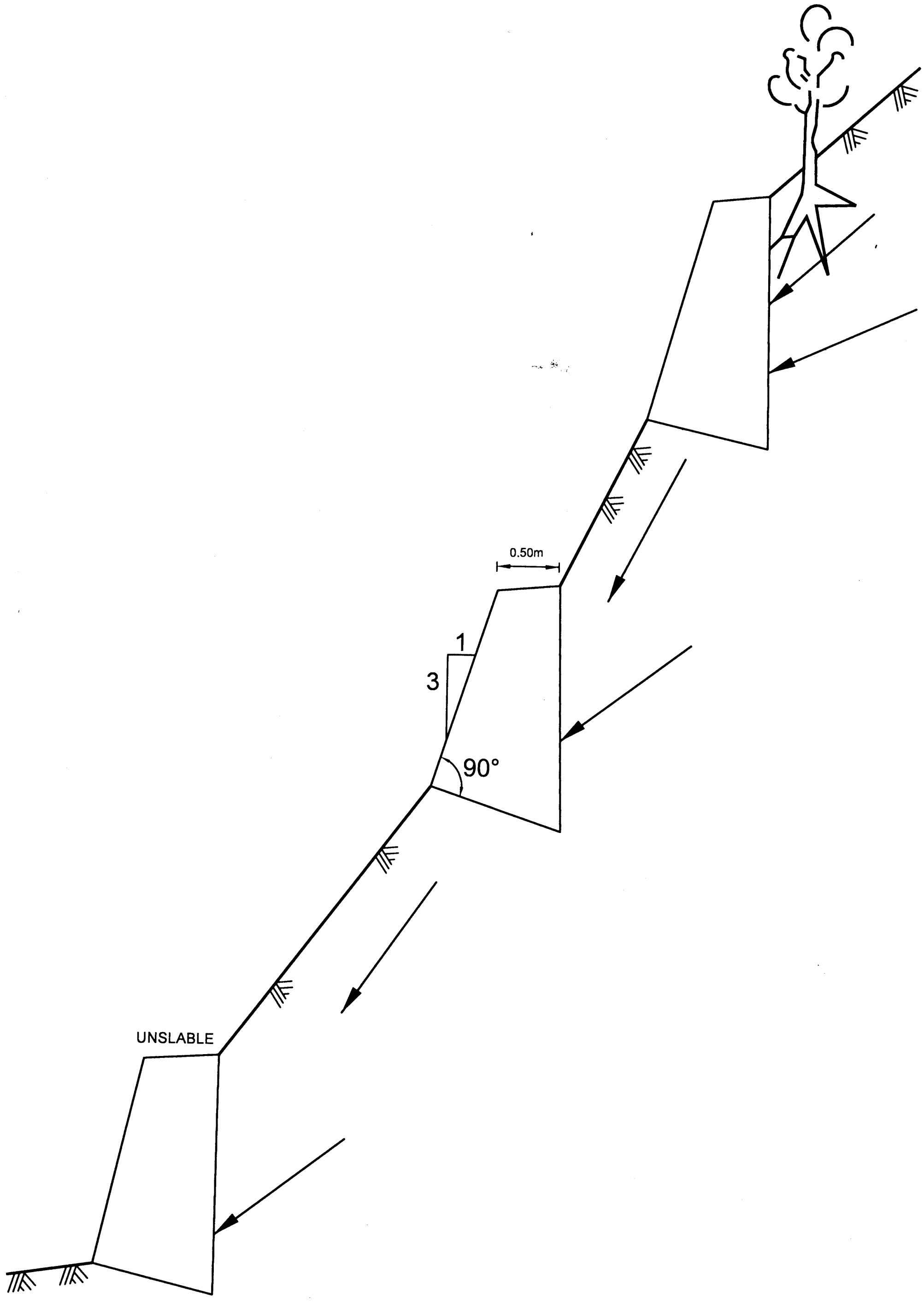


FIG. 1 DESTABILIZATION OF SLOPE BY SERIES OF RETAINING WALLS

masonry stones. Other rock types like quartzite, well lithified sandstones, limestones, massive granitic gneisses and other such hard rocks can also be used as masonry stones.

5 BASE SLOPE

An inward slope of the base provides good keying of the wallinto the hill and also helps to reduce the toe pressure, besides greatly increasing the sliding strength of the wall at the base (*see* Fig. 2). A minimum inward slope of 1 (Vertical) in 6 (Horizontal) in the base shall be provided and it shall not be more than 1 (Vertical) in 3 (Horizontal). Base slope is very effective in seismic stability of walls.

6 STONE WORK

Fresh to fairly fresh rough rectangular flat stones are more preferred as they give better contact and friction at joints. However, the available boulders can be shaped into rectangular pattern and used. There shall be no dumping of stones. Dry stones shall be hand placed tight and well interlocked with each other. The dry stones used for construction shall have a maximum size of 300 mm × 300 mm × 200 mm with a weight of about 40 kg and the minimum size of 100 mm × 100 mm × 200 mm with a weight of about 5 kg. The largest dimension stones shall be placed across the length of the retaining wall for maximum stability. The stones shall be placed well packed within the bands of cement stone masonry.

7 PLACEMENT OF BACKFILL

The backfill behind the wall shall consist of inverted filter for a thickness of 700 mm-800 mm. The inverted filter shall have materials ranging in size from boulder to sand, with boulders placed immediately behind the wall and sand towards the hill side. The filter should consist of three zones: about 300 mm thick layer of small boulders (30 mm-40 mm in size) close to the wall, 200 mm to 250 mm thick gravel fill (5 mm to10 mm in size) in the middle and 200 mm to 250 mm thick coarse sand (2 mm to 4 mm in size) further inside. The material of inverted filter should be properly packed behind the retaining wall in layers of 200 mm to 300 mm to cover the whole height, leaving about 500 mm to 700 mm space towards the top of the retaining wall. On the top close to the surface, natural soil or impervious clay soil shall be placed and compacted well to prevent ingress of surface water directly into the filter. The surface material should be filled in such a way that it forms a minimum slope angle of 10° or more. Grass or other green plantation may be grown on the top slope surface. The inverted filter is essentially required as it will help to drain out the subsurface water. A typical sketch of retaining wall with backfill material and the top layer is shown in Fig. 2.

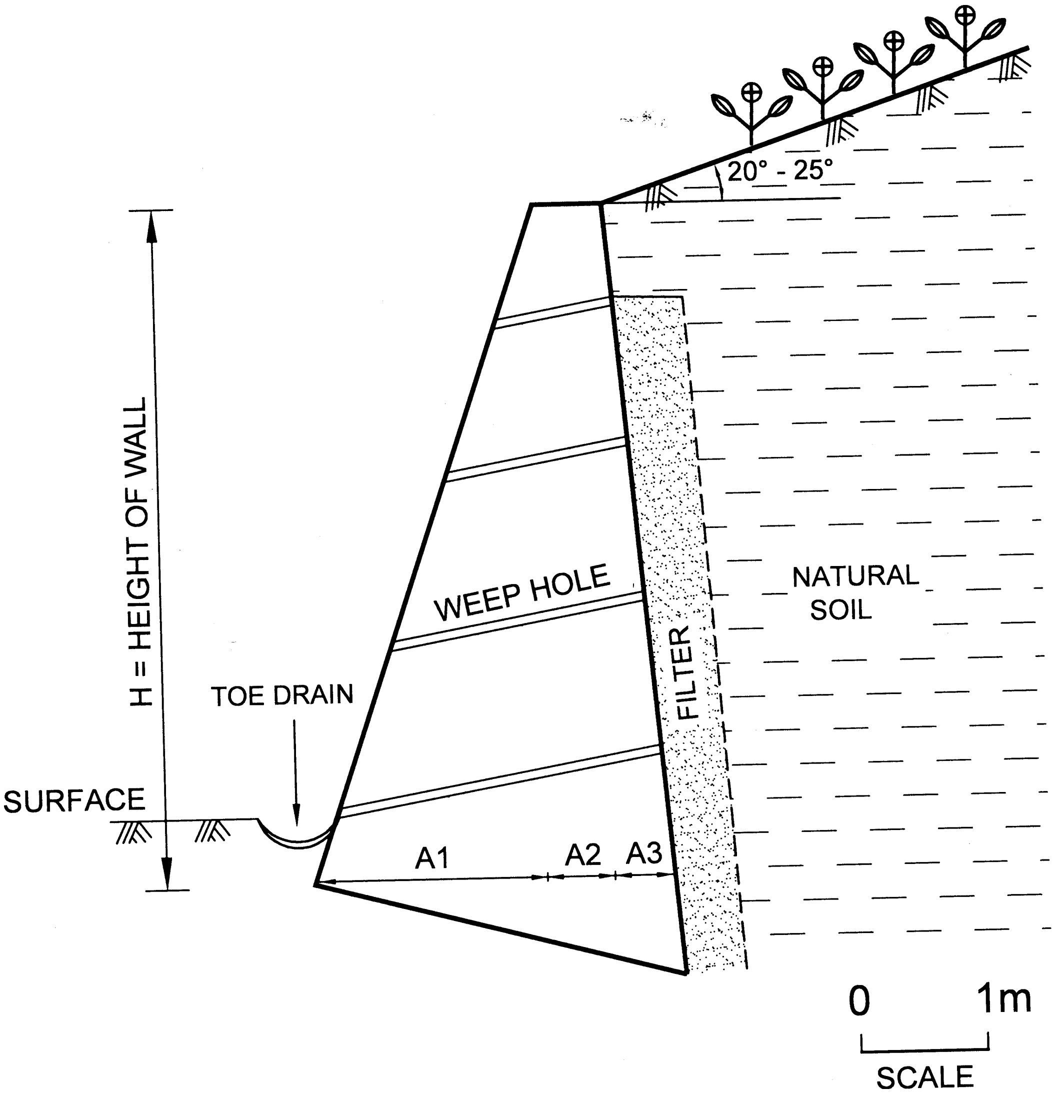


FIG. 2 TYPICAL SKETCH OF RETAINING WALL WITH BACKFILL MATERIAL AND THE TOP LAYER

8 DRAINAGE

Since about 80 percent of the banded dry stone retaining walls are made up of dry boulders placed one over the other, the collected seepage water in the backfill will be freely drained out. Therefore, there is no separate need of providing weep holes in the wall.

9 TOE PROTECTION

If the retaining wall is located on the hill side end of road/terrace, a 500 mm size curved toe drain (*see* Fig. 2) may be provided with a gradient of 1 (vertical) : 20 (horizontal). This will help to collect the drained water through the wall and safely dispose it off. However, if the wall is located on the valley side end of the terrace or no toe drain is provided, the toe of retaining wall should be suitably protected following anyone of the methods suggested in Fig. 3, as otherwise, the toe erosion may lead to destabilization of the wall.

10 CEMENT STONE MASONRY BANDS

The banded dry stone masonry wall should be provided with a minimum of 500 mm thick cement masonry bands at regular intervals of 2 m centre to centre in horizontal and vertical directions. The space in between the bands shall be packed tightly with dry stones (*see* **6** for details).

If the foundation is weak or the soil not well compacted, a 200 mm to 300 mm thick RCC raft shall be provided just below the bottom-most cement stone masonry band. For increasing the shearing resistance between the raft and the ground below, a series of 10 mm to 16 mm diameter steel bars shall be driven into the soil below RC band up to a depth of 2 m at 500 mm centre-to-centre using a jack hammer. The free end of the bars shall be tied to the reinforcements of RC band. Further it is advisable that the reinforcements from the raft shall penetrate into the bottom-most cement stone masonry band of the retaining wall for better bonding between the raft and the masonry section

11 APPROACH TO DESIGN OF RETAINING WALLS

The level of efforts required for designing retaining walls are different depending on the resources available. However, depending upon the height of retaining walls, the following approach can be used.

11.1 Design Consideration

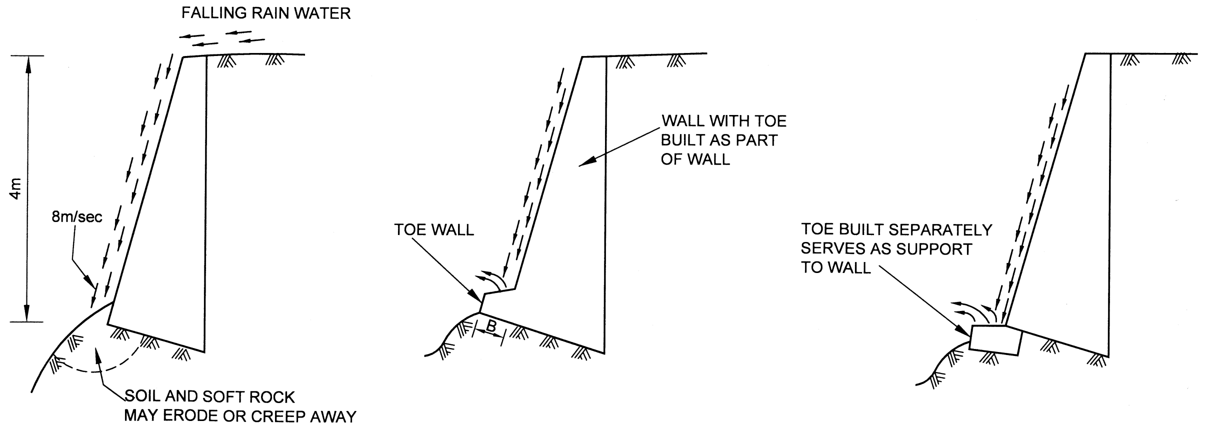
The banded dry stone masonry retaining walls up to 3 m height can be designed by the following thumb rule:

a) Top width = 0.50 m, and
b) Base width = 0.65 to 0.70 times the height of walls.

In general, it is not desirable to construct banded dry stone walls for heights more than 3 m. However, the height can be increased to a maximum of 4 m in exceptional cases.

11.2 Depth of Foundation

The depth of foundation of the retaining walls may be kept at 0.50 m to 0.75 m.


FALLING RAIN WATER
4m
8m/sec
SOIL AND SOFT ROCK MAY ERODE OR CREEP AWAY
WALL WITH TOE BUILT AS PART OF WALL
TOE WALL
B
TOE BUILT SEPARATELY SERVES AS SUPPORT TO WALL

3A Without Toe 3B Dissipation of Water Energy 3C Toe Built Separatly Serves as Support to Wall

FIG. 3 TOE PROTECTION FOR RETAINING WALLS

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Hill Area Development Engineering Sectional Committee, CED 56

Organization	*Representative(s)*
Indian Institute of Technology Roorkee, Roorkee	Dr R. Anbalagan (***Chairman***)
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